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ABSTRACT OF THE DISCLOSURE

5 An apparatus and method for interfacing the motion of a user-manipulable object with a computer system includes a user object physically contacted or grasped by a user. A 3-D spatial mechanism is coupled to the user object, such as a stylus or a medical instrument, and provides three degrees of freedom to the user object. Three grounded actuators provide forces in the three  
10 degrees of freedom. Two of the degrees of freedom are a planar workspace provided by a closed-loop linkage of members, and the third degree of freedom is rotation of the planar workspace provided by a rotatable carriage. Capstan drive mechanisms transmit forces between actuators and the user object and include drums coupled to the carriage, pulleys coupled to-grounded actuators, and flexible cables transmitting force between the pulleys and the drums. The flexibility of the  
15 cable allows the drums to rotate with the carriage while the pulleys and actuators remain fixed to ground. The interface also may include a floating gimbal mechanism coupling the linkage to the user object. The floating gimbal mechanism includes rotatably coupled gimbal members that provide three degrees of freedom to the user object and capstan mechanisms coupled between sensors and the gimbal members for providing enhanced sensor resolution.

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